ɣricultural Series, No. 12.)

THE

AGRICULTURAL LEDGER.

1895—No. 5.

DAIRY FARMING AND DAIRY PRODUCE.

DICTIONARY OF ECONOMIC PRODUCTS, Vol. III., D. 15 a.)

MILK AND MILK PRODUCTS.

ote by **Mr. JAMES MOLLISON**, *Superintendent, Government Farms, Bombay.*

Other DICTIONARY articles that may be consulted:

Butter, *Vol. I.*, B. 983.
Dáhi, *Vol. III.*, D. 15.
Ghi, *Vol. III.*, G. 189.
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(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

E. C. BUCK,
Secretary to the Government of India.

Agricultural Series, No. 12.)

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DAIRY FARMING AND DAIRY PRODUCE.

[*Dictionary of Economic Products, Vol. III.*, D. 15 a.]

MILK AND MILK PRODUCTS.

Note by MR. JAMES MOLLISON, *Superintendent, Government Farms, Bombay.*

Indian cows and buffaloes compared with European.

The milk of neat cattle varies considerably in composition. Certain eds yield richer milk than others. Excepting Channel Island cattle, milk breeds of Europe yield milk which is poorer in quality than average of Indian cows. The average yield of selected Indian vs is much less than that of good specimens of any improved milch ed. Choice specimens of Jersey or Guernsey cows yield 30 lbs. or re per day of rich milk, whilst Holstein and Shorthorn cows have h a record of over 70 lbs. per day, though in quality the milk is poor. e yield of Indian cows rarely exceeds 20 to 25 lbs. per day. Twelve 16 lbs. more nearly however approximate the average of good cows ull profit. Buffaloes on an average give considerably more than vs in India, and their milk is also much richer. Under skilful nagement there is no reason why the milk breeds of India should be very much improved. It is quite within the bounds of posility to breed up Indian buffaloes to become one of the best butterducing breeds in the world. The best results respectively from a falo and a cow during the years 1891—93 on the Poona Government rm are tabulated below :—

Milk yields of cows and buffaloes at Poona Government Farm.

	Number of Days in Milk.	Total Yield of Milk.	Number of Days Dry.	Value of Milk at current market rates.
		Lbs.		Rs.
alo	459	6,669	127	417
... ...	471	5,024	44	335

N.B.—Giving 1 lb. of butter for 11 lbs. and 17 lbs. milk respectively for buffalo and cow.

B 1845—1

MILK.

The comparative richness of milk may be gauged by the following analyses :—

Average composition of milk.

		Average composition of Milk.		
		Indian Cow.	Indian Buffalo.	English Cow.
	Water	86·13	82·05	87·20
Solids.	Butter fat	4·80	7·98	3·70
	Casein and albumen	3·03	4·00	4·00
	Milk sugar	5·34	5·18	4·40
	Ash	0·70	0·79	0·70

Quality of milk influenced by food.

The food given to milch cattle influences the quality of the milk to a considerable extent. Succulent food undoubtedly causes increased secretion, but at the same time it lowers the percentage of total solids. The morning's milk is usually not so concentrated as the evening's milk, but on the other hand the morning yield is greater. It is not clear why this increased yield should be associated with a diminution in the percentage of solids, unless we presume that the longer period which generally elapses between the evening and morning milking permits of fuller and freer secretion than the shorter interval between morning and evening. The observations taken at the Poona Government Farm show about one per cent. difference of total solids in favour of the evening's milk which is, however, more than counterbalanced by the increased yield in the morning.

Condition of constituents of milk.

The butter fat exists in milk as butter globules of various sizes easily discernible under the microscope. The butter globules are of lower specific gravity than the other constituents of milk. Consequently if the milk is set in a vessel, the butter fat rises to the surface to form cream which can be separated by skimming. In the milk the casein also exists in suspension in minute globules. In fresh milk the casein neither tends to rise nor sink because it has absorbed part of the water of milk and is thereby softened and swollen, so that it is more evenly diffused through the water of milk. The sugar of milk is in solution; the mineral matter is partly in solution and partly held in suspension. It consists mostly of phosphates and common salt. The ash constituents are oxides of iron and alumina, magnesia, potash, soda, lime and phosphoric acid.

Change by fermentation.

Milk rapidly undergoes change, particularly if the day temperature is high. The changes are induced by bacterial ferments which thrive in the milk because it is almost a perfect food. The most common change which occurs in the souring of milk is brought about by the

MILK.

rsion of sugar of milk (lactose) into lactic acid. The curdling of is an accompaniment of the lactic fermentation. This curdling oe accomplished artificially by means of an organic or mineral r, as in cheese-making, by precipitating the casein by the use of t. The active principle in rennet is the digestive agent found in urth stomach of a calf. It not only curdles the casein but also es other changes which lactic acid cannot induce. The change of e into lactic acid is merely a molecular one and is due to the h of the **Bacterium lactis**, an organism plentiful in the air of a but particularly where the dairy is not kept scrupulously clean. diately milk is drawn from the udder it is subject to contamina-

Causes of fermentation.

The chemical changes which then take place are directly caused rments induced by contamination. The temperature of the milk is drawn from the udder is just the temperature at which the duction of microbes takes place most rapidly. If milk is cooled diately bacterial growth is checked and will not again become e until the milk slowly warms which it will do if the temperature e dairy is higher than that of the cooled milk. If the dairy tem- ure is high, the milk will not keep long; if it is low the milk will in sweet a considerable period. Milk which has been boiled hen rapidly cooled and afterwards kept in a cool clean place keep longer than milk not so treated; but if the surroundings e dairy are unsanitary, or if the dairy is within range of any olesome smell or other unhealthy influence, the milk is bound come tainted in a manner which probably will make it dangerous uman food. Milk sours quickly in India during the hot season lso during the first part of the monsoon. During the early rains tmosphere is close and sultry, and though the heat is not excep- lly oppressive, there is "thunder in the air", and any atmos- ic electrical disturbance has a material effect in causing milk ur quickly.

ilk as it is secreted may be contaminated by delcterious sub- ces in the food; moreover a diseased cow may yield milk which be impregnated with disease germs and may therefore be the is of causing contagion, but as it leaves the udder it contains no entative bacteria. A few hours after milking the number of erial germs found in a cubic inch of milk is almost incredible, icularly if the temperature favours reproduction. The bacteria h cause fermentative changes in milk can be destroyed or at their development and activity can be stayed in many ways.

oracic acid, carbonate of soda and saltpetre are all used as milk ervatives, the first being the most effective. These agents do not roy fermentative organisms, but only check their development.

Means of preventing fermentative changes.

the udders of the cows and the hand of the milker are clean, if milk vessels have been thoroughly washed and well scalded, if the s are milked in a pure atmosphere and if the udders are not inflamed

MILK.

or otherwise diseased, it is clear that the danger of organisms entering the milk is minimized.

But fermentative bacteria always exist in the air and it is practically impossible to prevent milk coming in contact with them; therefore other precautions to prevent fermentative changes are necessary.

Heat will kill all organisms in milk. If the heat applied is high enough, milk will be sterilized. Boiling will kill all bacteria. If boiled milk is kept out of contact with the air it will keep indefinitely. Preserved or condensed milk is prepared by evaporating milk to which sugar has been added until the mixture acquires the consistence of syrup. Whilst hot it is hermetically sealed in tins and keeps good for years. A high temperature kills the ferments of milk, a low temperature interrupts their activity if it does not actually destroy them. Milk, kept frozen, will keep good for months, whilst a mean temperature of 35° to 40°F. is sufficiently low to keep it good for days. A maximum day temperature of 55° F. will enable milk to be kept good sufficiently long to allow all the fat globules to rise to the surface. Whilst if the mean day temperature is 70° F. or higher the lactic ferment is so active that lactic acid is formed in sufficient quantity to curdle the casein in a very short time, and the curdling entangles the butter fat globules so that they cannot rise to the surface. Milk sours so quickly in India that in order to get fresh cream the use of a De Laval Separator becomes almost compulsory. The separator will be found economical in other ways. By means of a separator the milk, so soon as it is milked, can be separated into its two products – cream and separated milk. The latter soon sours, but the former must be kept to ripen before it can be made into good butter. The separation of whole milk by mechanical power makes a large dairy unnecessary, for no room is required for the numerous vessels otherwise needed for setting the milk. If it is found necessary to raise cream by the ordinary milk-setting process in India, the quicker the cream is made to rise the better the results will be; because even under the most favourable conditions it is improbable that all the cream can be skimmed off before the milk has thickened by turning sour. The loss can be avoided if the milk is maintained at an artificially low temperature by means of ice. Cream rises quickest in a falling temperature, and to expedite the process on practical lines in India I should recommend that shallow vessels be used, that these be placed in pans containing the coolest well water procurable, or that water be cooled specially for the purpose by allowing it to filter through a series of earthenware chatties. It is well enough known that if porous earthenware vessels are placed on a stand one above the other so that the water passes from one to the other, even though the temperature of the atmosphere is high, evaporation takes place which lowers the temperature of the water so that, that which collects in the lowest vessel is comparatively cool

Utility of the De Laval Cream Separator.

Cream raising.

Milk Products. (*James Mollison.*)

MILK.

and is ordinarily of sufficiently low temperature to rapidly lower the temperature of new milk, provided the milk is set in its vessel in the water. This is a cheaper method of rapidly cooling milk than the use of ice. There is however one objection. If milk is cooled below the temperature of the surrounding air, it will (like any other cold substance) condense the moisture of the surrounding air and along with this moisture it will absorb any taint or odour existing in that atmosphere. Impure air under these conditions will certainly injure milk. The point therefore to be sure of is that the dairy is thoroughly ventilated and that the air which circulates through it is pure. If on the other hand milk at a comparatively high temperature is exposed to air of a lower temperature the latter will certainly be the absorbent. These statements tend to show that the refrigerator in common use in dairies is of no great value. The refrigerator is designed to aerate milk and at the same time to cool it. The refrigerator is essentially a continuous tube ranged like a "worm" inside a frame. Cold water is made to circulate through the continuous tube whilst the milk passes as a thin film over the metal frame; the milk is cooled and at the same time is thoroughly exposed to the atmosphere so that the animal odour which invariably impregnates new milk is driven off. It is at the same time thoroughly exposed to the oxidizing influence of pure air. This refrigerating process is employed to prepare milk for conveyance by road or rail in closed vessels to considerable distances and the milk is undoubtedly all the better for the treatment.

Cooling and aerating milk.

The Refrigerator.

I have found that in hot weather milk so treated is further preserved against any fermentative change if the vessels are covered with hoods of wet canvas. The heat of the sun or of the air evaporates the water from the hood and the heat necessary for volatilization of water is derived partly from the milk which is of course further cooled.

Milk prepared for transport.

A cool well ventilated dairy kept scrupulously clean is as necessary in India as elsewhere. A well planned and well arranged dairy would, in India, have high walls with a considerable air space between the ceiling and the double tiled roof. Either a cement concrete floor or a stone floor does very well, but the joints of the latter should be well cemented. The walls also should be plastered with cement to height of three or four feet or tiled, and there should be no underground drain. Milk must necessarily be spilled from time to time on the dairy floor, and if there are crevices in the floor or walls, small quantities of milk are sure to enter and ferment and cause unsanitary conditions which should be avoided. The windows and doors of the dairy should face the west or north. The main walls should be of considerable thickness and a veranda all round will still further help to keep the dairy cool. If the windows open inwards and wire gauze

The dairy and its equipment in India.

DAIRY EQUIPMENT.

is stretched upon and tacked to the window frame, ventilation will be secured whilst flies and other insects will be excluded.

The wash room with a built-in copper boiler should be a separate building.

The dairy for a herd of 20 to 40 milk cattle should be equipped as follows:—

	Rs.	a.	p.
One Laval Separator "Alpha Baby"; separates 30 gallons per hour; complete	360	0	0
Refrigerator with stand and fittings, complete, with two block tin drums or receivers	190	0	0
Six block tin pails	36	0	0
Two milk strainers, one fitted with wire gauze, the other with muslin.	5	0	0
Two hair sieves...	3	0	0
Sandringham Herd Recorder with pail and tripod with weighing milk	35	0	0
Iron scales with China pan for weighing butter	14	0	0
Temperature can...	4	8	0
Thermometer	2	8	0
Half pint, 1 pint and 1 quart measures with hook handles... ...	5	0	0
Victoria Churn (No. 3) to churn 40 lbs. of cream	85	0	0
Cunningham butter worker	45	0	0
One pair Scotch hands, one pair scoops and one pair beaters for handling butter	10	0	0
Moulds and prints for making 2 oz., 4 oz., and 8 oz. pats of butter.	3	0	0
Set of three cleaning brushes for churns, cans and separator ...	4	8	0
One gallon refined oil for separator	4	0	0
Total ...	806	8	0

CREAM SEPARATORS.

Cream-separators as now manufactured are simple and effective and although protected by patents, which necessarily enhance their value, are still moderately cheap. They vary in size and price. The hand power machines can effectively separate 30 to 40 gallons of milk per hour. The larger horse or steam power machines separate 200 gallons or more. The principle of all is the same. The milk is fed at a regular rate into a cylinder which revolves at high speed. The rate of revolution is so great that it exercises centrifugal force on the milk constituents. The lighter cream forms itself into a column which occupies the centre of the cylinder while the heavier separated milk is thrown against the inner wall of the cylinder; each product escapes separately from the cylinder and runs through separate tubes into different vessels. The De Laval "Windsor" hand-power machine is the one in most common use in India. It separates 35 gallons per hour and costs in England £2

The "Windsor" Separator; how worked.

For thorough separation the handle should be worked at a regular rate of 38 revolutions per minute; if worked at a higher rate, the cream comes thick; if at a lower rate, separation is not complete. The driving power is obtained partly by cog-wheels and partly by friction pulleys. The cylinder revolves on the latter. If the friction pulley

CREAM SEPARATORS.

coated with oil, the cylinder partly turns with and partly slips upon friction pulleys, and therefore although the handle gets the correct mber of revolutions, the cylinder does not turn at the proper rate ich is about 6,500 revolutions per minute. To safeguard against this or the friction pulleys should be rubbed free of oil immediately before rting the machine. The separator should be set accurately level d fixed, so that it cannot be dislodged from its position. All its rts must be kept scrupulously clean and the friction portions be ularly oiled with the purest lubricating oil obtainable. Milk ould be warm when undergoing separation. The temperature at ich it is drawn from the udder is sufficiently high. If milk is lder than 90°F. before it is brought to the dairy, it must be raised at least that temperature before it is separated. This is specially cessary with buffalo milk which ordinarily is extremely rich in tter fat. A temperature can, *i.e.*, a tin vessel with a tight fitting , and containing hot water, if dipped into milk and gently moved rough it, will soon raise the temperature to the desired standard. l milk before separation should be well strained first through a re or hair sieve and then through muslin, a double-fold of which y be stretched on a strainer frame of ordinary form. If the antity of milk to be strained is considerable, both the wire and slin strainers should, from time to time, be rinsed in pure water the straining proceeds. This should be done as often as there is y observable accumulation of foreign matter on the strainers.

The products of separation.

Complete separation means that less than $\frac{1}{2}$ per cent. of butter fat nains in the separated milk. It may be stated that approximately ole buffalo milk yields $\frac{1}{6}$ cream and $\frac{5}{6}$ separated milk, and that 2 lbs. the cream will yield from 1 lb. to $1\frac{1}{4}$ lbs. of butter. A pound of tter can be made from 9 lbs. of milk, if rich, but it will take 16 lbs. make the same quantity if the milk is poor. Buffalo milk is so h in butter fat that the ordinary lactometer as graduated for in England is necessarily misleading in India—thus it will indicate t separated milk is of better quality than whole buffalo milk. To ke this plain it may be stated that the lactometer will show pure k when 8 per cent. of water has been added to separated milk.

The Lactometer test misleading.

BUTTER.

Slightly salted pure butter should contain approximately :—

Water	7·5
Salt	1·1
Casein	0·6
Milk-sugar	0·3
Butter fat	90·5

Butter can be made to take up water to the extent of nearly per cent. The presence of a high percentage of water indicates t the butter has not been properly washed; because the removal butter-milk and other impurities from butter implies not only

BUTTER.

thorough washing, but thorough working or squeezing also. The process should not leave more than 10 to 12 per cent. water in the butter. Imperfectly washed butter contains butter-milk and curd. The nitrogenous substance, casein, is highly fermentative and the presence in butter of even a small percentage causes the butter soon to turn rancid. Rancidity is believed to be due to a chemical change, *i.e.*, the splitting up of butyrine into butyric acid and glycerine. Air and light are necessary to initiate the change. The melting point of butter is of some importance. It is a means by which expert analysis can detect whether it has been adulterated with animal fat or vegetable oils. The food given to dairy animals however influences the melting points. Those foods, which are least astringent, produce the softest butter. Cotton seed, pulse meal, pea straw and other pulse fodders, also groundnut cake produce firm butter; whilst many oil cakes give soft greasy butter. A simple and homely method of detecting impurities in butter is to place a small piece in a test tube and plunge the test tube into hot water. The butter melts and separates into layers which will indicate approximately the relative proportions of its constituents. The clarified butter *(ghi)* will form the upper layer, the curd a middle thin layer dividing the *ghi* from the water which will occupy the bottom of the test tube.

Rancidity induced by imperfect washing.

The food which influences the quality of butter.

A simple test of purity.

Cream after it has been separated from the milk is ripened in an earthenware jar, covered with muslin not with an air-tight lid. During ripening the cream should be frequently stirred at least once every two hours. The time required to ripen cream depends upon the temperature. Cream will be sufficiently ripe in 12 hours if the temperature of the dairy is from 65° to 75°F., in less time if the temperature is higher. A greater period must elapse if the temperature is lower. During the early monsoon rains cream will ripen more quickly than in the hot weather. Cream is ripened with the object of making it yield a greater proportion of butter of finer flavour than that obtained from fresh cream. The flavour is believed to be developed by the growth of a microbe in the cream. The fermentation which proceeds during the ripening process causes the cream to thicken. Cream is not pure butter fat, for milk in variable proportion is always present, and this milk sours as the cream ripens and the lactic acid precipitates the casein. The curd thus formed may during churning become incorporated more or less with the butter. Butter thus made will not keep long. If the sourness of ripe cream is excessive the curd forms in lumps; if the ripe cream is only slightly acid the precipitated casein breaks up into particles of minute size during churning and these particles always form a constituent portion of the butter-milk which ordinarily by thorough washing can be separated from the butter. The butter which will keep longest is made from fresh cream whilst the butter with the finest flavour is made from ripened cream. The combination of keeping quality and flavour is a point of value. It has been authoritatively stated that

Ripening cream.

een accomplished on the continent of Europe by inoculating m with a pure culture of the cream ripening microbe.

BUTTER.

ordinary method of hastening the ripening of cream is to a little sour milk which, however, must be clean and free foreign taint or flavour.

er should be made in India in the early morning when the ool.

Butter making.

cream before it is churned should be cooled; 55°F. or he proper temperature.

mperature of cream is lowered by adding ice or by setting the *its vessel* in cold water. The cooler the cream is churned, ner the butter will be. The churn should revolve about 55 er minute. The best results are got when the butter comes in hour. If it comes much sooner it is probable that the cream en over-ripened. If the cream is not equally ripe, *i.e*, if during ing it has not been well stirred and thoroughly exposed *equally* to ir, that at the bottom of the vessel will be less ripe than that at op, and in the process of churning the ripe or overripe portion of ream will form into butter granules first. If this occurs a good of cream which has not been converted into butter will be ved with the butter-milk, and will be lost unless the butter-milk pt for 24 hours, during which period the unchurned cream will rise e surface of the butter-milk and may be skimmed off. In India od deal of cream is recovered in this manner during the hot her. Even under the most careful management some cream will be in the butter-milk at this season. The cream from buffalo's milk be churned at a higher temperature than that from cows and yet uce equally firm butter. The feeding of the milch-cattle, as dy noted, also influences the temperature at which firm butter be churned. Colouring matter, if desired, should be added before ning. It is made from 3 oz. annatto seed digested for an hour in pure olive oil and then strained through fine muslin. One tea- nful is sufficient for the cream of 40 lbs. buffalo's milk, *i. e.*, for t 4 lbs. of butter. Colouring matter, which is more concentrated, ade as follows: 4 oz. of ground annatto seed is put in a glass flask just covered with rectified spirit. This mixture is allowed to st for 7 days. The rectified spirit dissolves the colouring matter the seed and a pure solution is obtained by straining through lin. This solution is however unsuitable for colouring butter use the spirit would taint the butter. The mixture is therefore d in a cooking vessel with 1 lb. of sesamum oil and carefully heat- he spirit is entirely evaporated and the solution is transferred to il. The colouring matter thus prepared is placed in a bottle when and kept corked to be used as required.

Loss of cream in the butter-milk.

Annatto colouring.

eam should only half fill the churn. It is churned into butter by tion. If the cream only half fills the churn the chief cause of

BUTTER.

Churning.

agitation is due to the cream falling upon itself at each revolution of the churn; if it completely filled the churn there would be no agitation at all. If the cream is so thick that it sticks to the churn, pure cold water should be added. The lid of the churn is now fixed down and the churn turned at the rate already indicated. The cream will froth up and swell after the first few revolutions. The air which was incorporated with it is driven out, and because it is impure air and in consequence may taint the butter, it ought to escape through a valve placed on the lid of the churn for that purpose. A small pane of glass is inserted in the lid of the churn. By careful observation the dairyman can see from time to time what is going on inside, and can determine when the butter begins to form. So soon as this takes place cold water (about $\frac{1}{10}$th of the cream quantity) should be added. The object is to lower the temperature when the butter is forming in order to get it firm, also to dilute the butter-milk so that it may the easier be separated from the butter granules. The necessity of lowering the temperature arises because the agitation which the process of churning requires has raised considerably the initial temperature. The churning is again continued until specks of butter on the glass are easily discernible and are seen distinctly separate from the butter milk. Experience and judgment are necessary to decide the right moment when to stop churning. If stopped too soon butter is lost in the butter-milk because the granules are so small that they pass with the butter-milk through the meshes of the finest strainer. If carried on too long the butter granules aggregate and the butter becomes greasy; moreover it is difficult to separate the butter-milk completely by subsequent washing and working without spoiling the grain or texture of the butter.

Removal of the butter milk and washing.

When churning is sufficiently advanced the butter-milk is drawn off through the tap hole at the bottom of the churn, and is strained through a sieve; and any butter caught is returned to the churn. The churn is half filled with pure cold water and given a few more revolutions and then kept at rest for a short period. If curd is present in quantity, it will settle to the bottom of the churn whilst the butter floats on the water. As the water is drawn off the curd may also be removed. If curd is present the butter caught on the sieve should not be returned to the churn, because it necessarily must be mixed with pieces of curd. If there is any considerable quantity it can be made into *ghi*. The churn is again half filled with water and given a few more revolutions. This water is likewise strained through a sieve as it is drawn off, and if there is no curd present, the contents of the sieve are again returned to the churn. The butter is now comparatively free of butter-milk, but in order that it may be washed, as far as possible, whilst still in a granular condition, brine is now added, the solution consisting of $\frac{1}{4}$th lb. salt to a gallon of water. The churn is again half filled and slowly revolved a few (say 3 or 4) times. The brine is drawn off and strained as before through a sieve.

BUTTER.

ıe butter is now sufficiently washed to be removed from the n to the butter-worker by means of two wooden scoops. The ver-worker is a simple arrangement whereby, in a wooden trough, ›oved roller kneads the butter completely free of butter-milk. butter-milk escapes down the inclined plane which forms the ›or of the trough and runs through a tap hole to a vessel placed to tch it below.

The butter worker.

When thoroughly worked the butter is in a condition to be made up to marketable form. By the use of "Scotch hands" and wooden ıtter prints or moulds, it can be made up at once into pats for imme- ıate sale. If it is necessary to keep the butter any time, it should be ›eserved with salt. One per cent. salt is sufficient to preserve butter ı good condition for a few weeks whilst 3 to 4 per cent. salt will ›ep it good for months.

Salting.

Fine table salt should be used. Before it is mixed with the butter should be powdered very fine with a roller (an empty bottle does ›ry well for the purpose). The salt should be mixed with the butter y thorough working on the butter-worker, a little salt being sprinkled ›ch time the butter is kneaded by the butter-worker. I have proved ıat butter preserved in this manner, if packed tight in earthenware crocks" with tight fitting lids will, in a comparatively cool place, eep good for months. Moreover, when required for use the butter ın be washed almost free of salt by the free use of pure cold water nd of the butter-worker. Improved dairy machinery is designed ›ith the object of making it unnecessary for the dairyman to touch ›ith the hands, either milk, cream or butter, which in India is a ›oint of significant importance.

CHEESE.

The principle of cheese making depends upon the casein of milk ›ing artificially curdled by means of rennet. A small quantity will ırdle a considerable quantity of milk. The casein entangles the ıtter fat globules, and this sinks separating from the whey. The hey contains the sugar, the albumen and the greater portion of the h constituents of milk, also a small proportion of butter fat. Whey ›used in Europe chiefly in feeding pigs and poultry. The curd is ıanipulated in various ways to produce different kinds of cheese. he Cheddar system of cheese making is perhaps the most common. heese varies in quality according to the quality of the milk from hich it is made. It varies in character according to the system lopted in making it. The finest soft cheeses are made from milk, hich has been improved by the addition of cream. Cheese made om pure milk is called whole milk cheese. There are numerous adations of quality between cheese of this class, and that made from immed or separated milk. A good whole milk cheese will contain out equal percentages of casein, butter fat and water and about 2 r cent. each of milk sugar, phosphates and common salt, the salt being lded as a preservative. Cheese made from buffalo milk approxi-

Curdling milk by rennet.

Different qualities of cheese.

DAIRY Farming.	Milk and

CHEESE.

mates Stilton in composition, which is a rich soft cheese usually containing about 27 per cent. casein, 42 per cent. butter fat and 23 per cent. water.

Appliances for cheese making.

The appliances required for cheese making are:—

(1) A vat, in which the milk is set and curdled, and the curd cut and "cooked".

(2) A curd knife.

(3) The curd cooler, on which the curd is exposed and ripened after it is removed from the vat.

(4) The curd mill, which grinds the curd into a granular condition before salting.

(5) Hoops or moulds, in which the curd is squeezed free of whey. The sides of the moulds are for this purpose perforated, also the bottoms. A round piece of wood fits loosely over the curd in the hoop, and bears the pressure applied to express the whey and consolidate the curd.

(6) The cheese press, to press the curd in the hoops. The pressure is applied by means of a screw, assisted by an ingenious system of compound leverage, which is increased as desired by adding weights, one by one.

Cheese making in India only partially successful.

Cheddar cheese has been made at Poona and at Aligarh in the North-West Provinces, by Mr. Keventer, a dairy expert. It has so far been found impossible to make cheese of uniformly good quality in India. The reason is that the temperature of the cheese room cannot be regulated, so that proper ripening of the cheese is ensured. At Poona it was found impossible to secure in the curing room an even temperature of 65° to 75° F. which, in order to obtain the best results, should be maintained with moist air. The experience gained proves that cheese making can only be economically practised in those districts of India, where the day temperature for a considerable portion of the year is moderately cool and where milk is produced at a cheap rate. The industry cannot be advocated in any district, where milk is dearer than 30 lbs. per rupee or where *ghi* (clarified butter) is worth more than 6 annas per pound.

At Poona cheese was made from whole buffalo milk, also from "reduced" buffalo's milk, the former containing about 6 per cent. butter fat, the latter about 3·5 per cent. The reduced milk was a half and half mixture of whole buffalo milk and separated milk, and had almost identically the same composition as an average sample of English cow milk. The best cheeses were made from whole milk.

Vegetable rennet.

Cheeses made with vegetable rennet ripened as well as those made from animal rennet, and in an equally short time. This proves that an extract from the berries of **Withania coagulans** can, not only coagulate milk but, digest and mellow curd into cheese. The use of **Withania** rennet removes the cause of the Hindu objection to cheese,

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ters no disadvantages over the animal rennet which could not rcome by care and experience. An overripe **Withania** cheese pes an acrid principle which gives an undesirable taste, whereas se that is just ripe has a peculiar flavour which is not disagree- I have no doubt that the tendency to decomposition could be d by storing the ripe cheese in a cool, dry, well-ventilated

It was observable throughout the Poona experiments that the om **Withania** rennet never developed the same desirable texture he curd from animal rennet did; moreover the smell of Vithania was more powerful than the characteristic odour deve- in the curd by a sufficient degree of acidity. Therefore an cheese-maker could not detect by his sense of smell when the ecame sufficiently acid.

Artificial colouring.

blue white colour of cheese made from buffalo milk is not ive and reduces the market value of the cheese. This of course e rectified by artificial colouring, which is more or less ed in all systems of cheese-making. The unusually higher tage of butter fat in buffalo milk gives a peculiar consistence ripened cheese. The curd remains somewhat granular during ening process and a clean slice cannot be cut with a sharp This peculiarity is noticeable to a less extent in cheese made educed milk.

as proved by the Poona experiments that in India milk can gulated and a quality of curd developed having the flavour and e which ought to make a high class cheese; but the maturing cheese afterwards cannot be regulated to give the best results. fference between the day and night temperatures was so great was impossible to maintain anything like an equable tempera- the curing room. The air, however, was kept sufficiently by sprinkling the mud floor occasionally with water.

Quality not uniform.

quality of the cheese made was not uniform. This was ly due to intentional variations in the method of manufacture, r to determine which method gave the best results. There ariations in the temperature of the milk when the rennet was and in the degrees of heat applied to the curd to create acidity, results were contradictory. The cheeses manufactured varied air to good, none could be classed as inferior. The best rennet cheese and the best **Withania** cheese were made from buffalo milk on the same day. Half the milk was kept over the other half was fresh. The temperature of the over-night as 70° F. at 9 o'clock in the morning. From it the cream was d and added to the morning's milk, and the temperature of the e raised to 102° F. The over-night milk was now added, and being thoroughly stirred to ensure proper mixing, 80 lbs. were away through a tap to be treated with **Withania** rennet in a sepa- t. One hundred pounds remained. This quantity was coagulated

Details of method of manufacture.

DAIRY Farming.

Milk and

CHEESE. Manufacture of

with animal rennet; 20 oz. of sour whey were added as a ferment to ripen the milk. Previous experience had shown that 1½ tablets of rennet extract was sufficient to coagulate 100 lbs. of milk in 45 to 50 minutes, and this quantity of rennet was used. It was dissolved in a little water and then added to the milk. The temperature of the milk was 86° F. The milk was well stirred to ensure complete admixture of the rennet, and was sufficiently coagulated in 50 minutes. Meantime the vat was covered with a cloth to retain warmth. The test of complete curdling is to pass a glass rod through the curd. If the curd breaks clean, coagulation is complete. The curd knife, which consists of a series of long sharp blades, set about ½ inch apart, was now gently used, first lengthwise and then across the vat, to cut the curd into sections. The curd slowly settled and got gradually firmer. The curd knife was now used more vigourously and the curd was minced into a fine granular condition. The cutting and stirring were continued for 55 minutes. The curd was then allowed half an hour's rest. Meanwhile a bucketful of whey was drawn off and heated. When the half hour's rest had lapsed, sufficient hot whey was returned to the vat to raise the temperature to 92° F. Curd and whey were kept in continuous motion for 35 minutes and then a second rest of 30 minutes allowed. Heated whey was again used to scald the curd, the temperature being raised to 98° F. After agitation for half an hour a third rest of 45 minutes was allowed. Sufficient acidity was now developed to permit the removal of the whole of the whey. The curd was now heaped up and kept warm by means of a cloth covering the vat until the proper flavour and texture were developed. In 65 minutes it was sufficiently acid to put on the cooler. An expert cheese maker detects by his sense of smell when curd has developed sufficient acidity. Another test is when a piece can be separated without breaking by finger and thumb into thin sections. The curd was left to ripen on the cooler for 70 minutes, and then ground in the curd mill, salted with 2 per cent. salt, put in a hoop, previously lined with a cloth and placed in a press. The curd was kept under pressure, which was gradually increased for 3 days, being changed from its hoop and cloth daily. On the third day it was neatly bound and sown with calico, and placed in a shelf to ripen, being turned daily during the first week and at increasing longer intervals afterwards. This cheese was made on the 21st February and was ripe on the 16th of May. One hundred pounds of milk produced almost exactly 10 lbs. of cheese which had an excellent flavour and otherwise would not be objected to by an expert judge. A **Withania** cheese, made on the same day from curd manipulated as to temperature, &c., in almost precisely the same manner as described above, was ripe on the 7th of May. In this case 80 lbs. of milk produced 7½ lbs. of cheese.

Vegetable rennet decoction.

The **Withania** rennet decoction is made thus: 3 oz. of salt are dissolved in 2 lbs. of water and 6 oz. of powdered dry **Withania** berries added to the brine. After digestion for 24 hours, the extract is

strained through fine muslin. One pound will coagulate 80 lbs. milk in 50 to 60 minutes. CHEESE.

A native churn consists of a vessel holding curdled milk. The curd is violently agitated by means of a beater. The beater is made to rotate first in one direction and then in the opposite by means of a rope turned two or three times round its handle. The free ends of the rope are held one in each hand of the operator and are pulled alternately. Indian Churn.

The vessels and plungers vary in size according to the quantity of milk dealt with. Those used in households are small, whilst those used by *gavlis* (professional milkmen) are large. The vessel is usually an earthenware pot.

The shape and construction of the plunger or beater varies. Sometimes if small it is worked by rapidly rotating the handle between the palms of the hands.

The beater of the Deccan churn consists of a wooden handle, on which a large head piece is fitted. The head piece may be of iron or of hard wood. It is cast or cut into a series of flanges and grooves, and this irregular surface is well calculated to agitate the curd thoroughly. The beater of the Konkan churn is very simple. It consists of a piece of bamboo slit up at one end into four segments. The segments are forked out and held so by two cross pieces at right angles to each other.

I note below the manner of making butter in a native churn with results from a given quantity of buffalo milk. The quantity treated was 5 lbs. The milk was boiled and then allowed to cool. Whilst yet warm a small quantity of sour butter-milk was added. The milk curdled into a thick soft mass. The curd was kept for 16 hours. Meantime the whey did not separate much. The curd and whey were put into the churn and agitated for about 4 minutes. This broke the curd up into a fine pulp. Pure cold water about the milk quantity was now added. The churn was again worked, and in about 12 minutes from the start butter began to collect on the surface. A second smaller quantity of water (1 lb. 4 oz.) was now added and agitation continued for 4 minutes more. All the butter had now come to the surface. It floated on the butter-milk, and when the beater was removed from the churn vessel, the butter was deftly gathered off with the hand. It was placed in a vessel which had previously been steeped in water, the wetness preventing the butter sticking to the vessel. Some of the butter-milk drained away, but the butter was not washed in any way, nor is it customary to wash it. The butter was soft; if it had been made earlier in the morning in a cooler temperature, it would have been firmer, and probably would have contained less water and other impurity. Seven and half ounces of butter were obtained. This is equivalent to 1 lb. of butter from 10⅔ lbs. of Native method of making butter.

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buffalo milk, or almost exactly the same proportion of butter to milk as that by improved methods. Butter churned from separated cream properly ripened is of course purer and more valuable and, moreover, the by-products (separated milk and butter-milk) are worth more than *tâk* (native butter-milk). The comparative purity of butter made as above described with that churned from ripened cream is indicated by the under-noted percentages of *ghi* (clarified butter) obtained from each :—

Comparative results of native and improved methods.

Native made butter gave 77·3 per cent. *ghi*.
Butter made from ripened cream gave 81·2 per cent. *ghi*.

GHI.

Ghi (clarified butter) is generally made in an open brass or copper vessel over a slow fire. By the conversion of butter into *ghi*, the impurities are to a great extent got rid of. The water evaporates away whilst the curd settles and coats the bottom of the vessel. As the boiling proceeds the melted butter at first boils vigorously, by and by less so. The test of complete clarification is when the *ghi* almost ceases to bubble and simply heaves in the vessel. The clarified butter is then strained through a sieve into another vessel, in which, if closed to the air, the *ghi* will keep good for months or longer. *Ghi* is generally sold wholesale in large narrow-necked vessels made of hide, and varies in price from 5 to 8 annas a pound.

MA'VA.

Máva or *khava* is a favourite native product made from whole milk. It is milk dessicated and sweetened with pounded sugar. The finest variety is obtained from the new milk of buffaloes immediately after calving. This milk has a special value, because the sweetmeats made from it keep good for a year or longer. It has been proved that *máva* can be made from separated milk, the cream being saved for butter or *ghi*. The product is of course inferior to *máva* made from whole milk. In the market much of the *máva* sold is made from partially skimmed milk, and is sometimes admixed with flour. *Máva* made from separated milk is at least not inferior to this.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry under the Forest Series, and those of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.